

Track reconstruction efficiency

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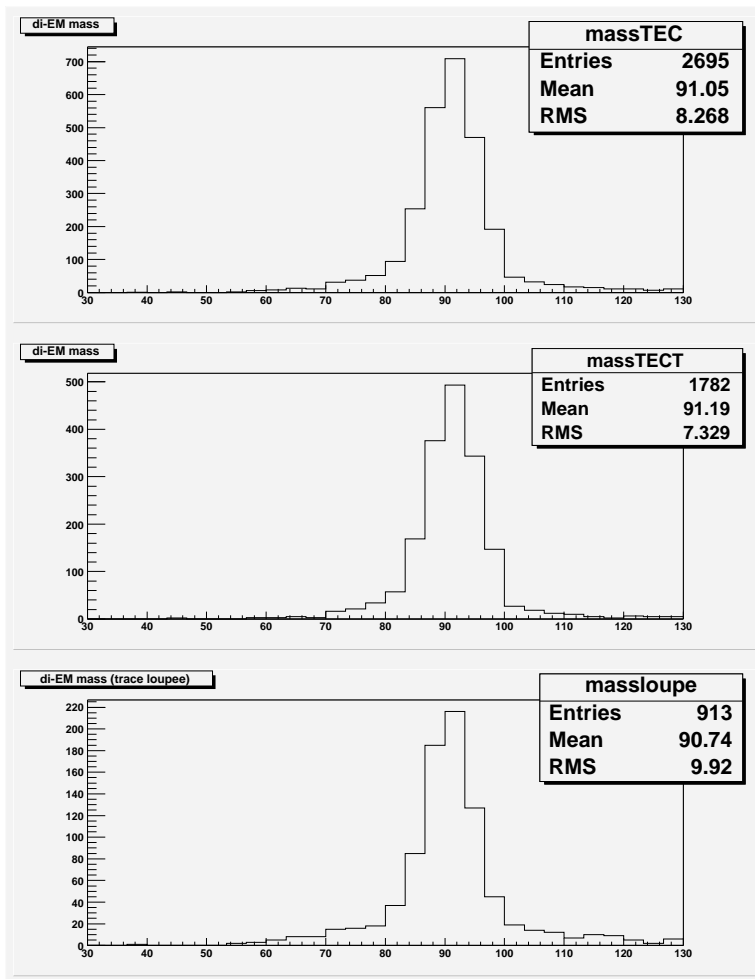
http://www-d0.fnal.gov/~rakitin/d0_private/tex/2006.Apr.06.Tralgo/tr.pdf



Tracking efficiency study:

Reminder: I use Jan Stark's data sample $Z \rightarrow e^+e^-$:

- One EM cluster in CC ("tag electron") – must have matching track
- Another EM cluster in end-caps ("probe electron") – does not have to have matching track



The plots of di-EM mass (© Jan Stark):

- Upper: all events
- Middle: probe electron has matching track (~66%)
- Lower: probe electron has no matching track (~34%)

- **Problem:** matching track isn't reconstructed for probe electron in one-third of cases
- **Resolution:** slight change of reconstruction algorithm may help

Method of study:

- Shoot an imaginary track from PV to EM cluster
- See which hits are close to it
- Understand why they were not composed into track

In my study I only use first 40 events from the sample in the lower plot

Reminder of proposed change in algorithm:

- All the tracks having 3+ hits in SMT Barrels are reconstructed with current algorithm
- Non-reconstructed tracks (40) can be divided into 5 categories:
 - ➡ Tracks with
 - either 2 hits in SMT barrels and 1 in F-disks
 - or 1 hit in SMT barrels and 2 in F-disks
 - (14 tracks out of 40)
 - ➡ Tracks with 2 hits in SMT and 4+ in CFT (6 out of 40)
 - ➡ Tracks with hits being further than “standard” 3σ window (2 out of 40)
 - ➡ “Invalid” tracks with too few axial or stereo hits (5 out of 40)
 - ➡ Tracks with too few hits to be reconstructed (13 out of 40)

By changing tracking algorithm we can reconstruct first three categories

Combinatorics will increase \Rightarrow must do timing studies too

First two changes are currently under investigation



Results

- ☞ SMT hits in barrels and disks may follow different patterns:
 - 2 in barrels + 1 in disk
 - 1 in disk + 2 in barrels
 - 1 in barrels + 1 in disk + 1 in barrel
- ☞ To take all these combinations into account let each hit be either in SMT barrel or in SMT disk
- ☞ Changed algorithm found 5 more tracks in sample of 40 events
⇒ tracking inefficiency decreased by 13%
- ☞ Unfortunately, changed algorithm does not find many tracks because the hits are too far from expected positions (8 out of 14 in addition to 2 from old algorithm)
- ☞ Time to find all tracks within one event increases by approximately factor of 2

Let's go through these results in detail...

“2+1” or “1+2” SMT hits:

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
164605 10233199	Probe	2	3	2	0	YES	Yes
	Tag	6	7	0	0	Yes	Yes
165805 2576564	Probe	2	2	2	0	YES	Yes
	Tag	0	7	1	0	Yes	Yes
166113 39215346	Probe	1	3	2	0	YES	Yes
	Tag	4	8	1	0	Yes	Yes
166295 20638511	Probe	1	0	2	1	No, invalid	???
	Tag	3	8	0	0	Yes	Yes
166302 24938931	Probe	1	3	2	0	No, hits too far	???
	Tag	3	8	0	0	Yes	Yes
166302 24109618	Probe	1	3	2	0	YES	Yes
	Tag	4	8	0	0	Yes	Yes
166506 46965463	Probe	2	4	1	0	No, hits too far	???
	Tag	2	8	0	0	Yes	Yes
164445 2159216	Probe	1	2	2	0	No, invalid	???
	Tag	2	8	2	0	Yes	Yes
166782 123665141	Probe	1	3	2	0	No, hits too far	???
	Tag	3	8	0	0	Yes	Yes
164605 7263701	Probe	1	3	3	0	No, hits too far	???
	Tag	2	8	0	0	Yes	Yes
166937 9714345	Probe	2	2	2	0	No, hits too far	???
	Tag					Yes	Yes
167325 3178494	Probe	1	1	2	0	No, hits too far	???
	Tag					Yes	Yes
168498 519484	Probe	1	2	2	0	No, hits too far	???
	Tag					Yes	Yes
168973 5391969	Probe	2	2	1	0	No, hits too far	???
	Tag					Yes	Yes

2 SMT hits and 4+ CFT hits (not investigated yet):

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
165977 6659303	Probe	2	4	0	0	No, 3-hit req.	Yes
	Tag	0	5	0	0	Yes	Yes
163171 48542536	Probe	1	4	1	0	No, 3-hit req.	Yes?
	Tag	0	8	0	0	Yes	Yes
163171 46651698	Probe	0	4	2	0	No, 3-hit req.	Yes?
	Tag	1	8	0	0	Yes	Yes
164039 14995544	Probe	0	4	2	0	No, 3-hit req.	Yes?
	Tag	3	8	0	0	Yes	Yes
166869 37137074	Probe	0	5	2	0	No, 3-hit req.	Yes?
	Tag	0	8	1	0	Yes	Yes
166868 36065427	Probe	1	4	1	0	No, 3-hit req.	Yes?
	Tag	3	8	0	0	Yes	Yes

Hits too far from track (with non-changed algorithm):

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
164080 30329930	Probe	0	7	0	0	No, hits too far	Yes?
	Tag	1	5	0	0	Yes	Yes
166872 41058810	Probe	0	5	1	0	No, hits too far	Yes?
	Tag	2	8	0	0	Yes	Yes

Invalid tracks:

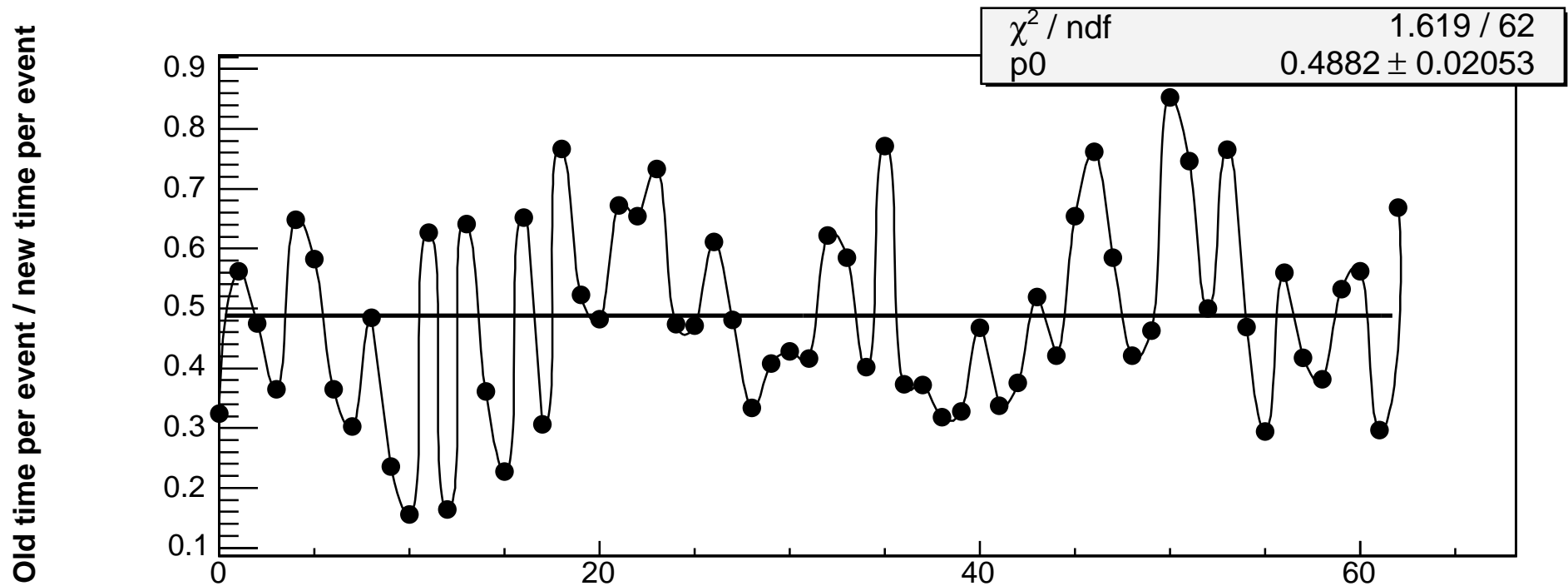
Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
164216 83479647	Probe	0	1	3	0	No, invalid	???
	Tag	1	7	0	0	Yes	Yes
164018 11142735	Probe	0	1	4	0	No, invalid	???
	Tag	3	8	1	0	Yes	Yes
164040 18660971	Probe	4	5	0	0	YES	Yes
	Tag	2	8	0	0	Yes	Yes
164083 35308948	Probe	0	0	3	0	No, invalid	???
	Tag					Yes	Yes
168525 19495531	Probe	4	5	1	0	YES	Yes
	Tag					Yes	Yes

Too few hits to reconstruct track:

Run/Event	Electron	SMT Barrels	CFT	SMT F	SMT H	Reconstructed?	Reconstructible?
165645 5273011	Probe	2	2	0	0	No	No, too few hits
	Tag	3	7	0	0	Yes	Yes
164636 16204878	Probe	0	0	2	0	No	No, too few hits
	Tag	0	8	1	0	Yes	Yes
165765 36883677	Probe	0	3	1	0	No	No, too few hits
	Tag	3	8	0	0	Yes	Yes
165686 45005141	Probe	0	2	1	0	No	No, too few hits
	Tag	2	8	1	0	Yes	Yes
164385 4847391	Probe	0	4	2	0	No	No, too few hits
	Tag	3	8	0	0	Yes	Yes
164382 3507437	Probe	0	2	0	0	No	No, too few hits
	Tag	0	7	0	0	Yes	Yes
166483 3946198	Probe	0	0	0	1	No	No, too few hits
	Tag	0	7	0	0	Yes	Yes
163172 49593518	Probe	0	0	0	0	No	No, too few hits
	Tag	0	7	0	0	Yes	Yes
166776 115353883	Probe	0	0	0	0	No	No, too few hits
	Tag	0	8	0	0	Yes	Yes
164605 6649931	Probe	0	0	1	1	No	No, too few hits
	Tag	0	8	0	0	Yes	Yes
164095 44036204	Probe	0	1	1	0	No	No, too few hits
	Tag	4	8	1	0	Yes	Yes
166898 16826502	Probe	0	3	2	0	No	No, too few hits
	Tag	1	8	0	0	Yes	Yes
168732 17138782	Probe	0	4	1	0	No	No, too few hits
	Tag					Yes	Yes



Timing studies



Fit with horizontal line \Rightarrow obtain 0.49 ± 0.02

\Rightarrow time per event increases approximately by factor of 2



Conclusion

Majority of the missing tracks from the “probe” electrons can be reconstructed by slight variations of the algorithm:

- Require 3+ hits in **both** SMT barrels and disks, not only in barrels
 - diminish tracking inefficiency **by 13%**
 - **processing time increases by approximately factor of 2** \Rightarrow to be improved
- **Allow hits to be further than 3σ away (maybe only for high- p_t tracks?)**
 \Rightarrow to be investigated
- **Allow for 2 hits in SMT (barrels and disks) if CFT has 4+ hits**
 \Rightarrow to be investigated